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Effects of rate and application time of nitrogen fertilizer on seed yield of Westerwolds ryegrass

by

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Introduction

Westerwolds ryegrass (*Lolium multiflorum* Lam.) can be grown in rotation with potatoes for diversifying crop production, maintaining soil structure, and managing diseases and pests. Seed production of Westerwolds ryegrass shows potential in Prince Edward Island where the day length and cool temperatures in the spring favour floral development and seed formation.

The aim of this research was to determine effects on seed yields of nitrogen fertilizer applied at 60, 90 and 120 kg ha^{-1}, either all at seeding or 60% at seeding and 40% at tillering stage, on three cultivars over a three year period

Materials and methods

The field experiments were conducted at the Crops and Livestock Research Centre in Charlottetown, Prince Edward Island. The soil was a fine sandy loam with a pH of 6.0 to 6.2. Fertilizer P and K were applied according to soil test results to maintain medium to high fertility levels of soil.

The plot size was 2 * 5 m and there were four replications. Seed was sown at 400 viable seeds m^{-2} or at the following rates of three cultivars in the study:

-Barspectra 13.8 kg/ha,
-Aubade 22.0
-Marshall 12.6

Seeding was completed during the first week of May with an Øyjord small plot drill. The row space was 20 cm and the depth of seeding 1 cm. Broadleaf weeds were controlled by DyVel at 1.25 L ha^{-1} (MCPA and dicamba).

Nitrogen fertilizer was applied at 60, 90 and 120 kg ha^{-1}, either all at seeding or 60% at seeding and 40% at the tillering stage.

The experimental design was a randomized block with four replications.

Results

This experiment was conducted over a three year period and results for this period are given in tables 1 and 2. Weather conditions ranged from warm and dry in May and June of 1998 and 1999 to cool and wet in 2000. In 2000 conditions appeared to favor development of fertile tillers which resulted greater seed yields than in the two other years.

- Aubade was the highest yielding cultivar (1440 kg ha^{-1}) followed by Marshall (1073 kg ha^{-1}) and Barspectra (742 kg ha^{-1}). Seed yield increased from 963 kg ha^{-1} to 1118 kg ha^{-1} when nitrogen rate increased from 60 to 90 kg ha^{-1}. Seed yields were similar for the 90 and 120 kg ha^{-1} rates of nitrogen. Applying all nitrogen at seeding or at seeding and at the tillering stage of ryegrass resulted in similar seed yields.
- The 1000-seed weight was greatest for Aubade (4.1 g) followed by Barspectra (3.7 g) and Marshall (2.5 g) but it was not influenced by nitrogen fertilizer.
- Density of fertile tillers ranged from 911 m^{-2} for Marshall to 541 m^{-2} for Barspectra. Tiller density increased linearly between the 60 and 120 kg ha^{-1} rates.
- Number of spikelets was greatest for Barspectra at 20.7 per seed head and lowest for Marshall at 17.9 per seed head. Nitrogen had little influence on spikelet numbers.
- Aftermath herbage yields for Barspectra and Marshall were about 2500 kg ha^{-1} dry matter in early October and 1873 kg ha^{-1} for Aubade. There was little evidence of residual N from applications at establishment as the dry matter yields for the rates were similar.
- Crude protein of herbage increased from 11.9 to 13.1 % as N rate increased from 60 to 120 kg ha^{-1}. Crude protein of cultivars was similar and timing of N application had no effect on crude protein of herbage.
- Barspectra was low both in neutral and acid detergent fibre. Rate and time of N application had no effect on NDF and ADF concentrations of herbage.
- There were differences in concentrations of Ca, Mg, P, K, S, Mn and B among the three cultivars. Rate

of N application resulted in small but significant differences in concentrations of Ca, S and Cu. It is noted that herbage was very low in Zn which needs to be taken into account in animal diets.

Conclusions

Average seed yields of 742 to 1440 kg ha^{-1} suggest that cultivars differ a great deal in their seed production potential in PEI. Response to N fertilization also varied among the cultivars which impacts on returns. There appears to be a direct relationship between the density of fertile tillers, but not between spikelets per tiller, and seed yield. Aftermath yields provide feed with excellent nutritional quality for late season grazing or biomass for maintaining soil resource.

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Table 1. Effects of rate and application time of nitrogen fertilizer on seed yield, plant characteristics and composition of Westerwolds ryegrass, 3 year means

	Seed kg ha^{-1}	TSW g	Tillers, plant $^{-2}$	Spikelets, seed head $^{-1}$	Aftermath kg ha^{-1}	Crude protein g kg^{-1}	NDF g kg^{-1}	ADF g kg^{-1}
Cultivar								
Aubade	1440	4.1	784	18.3	1873	12.9	612	362
Barspectra	742	3.7	541	20.7	2541	12.3	579	327
Marshall	1073	2.5	911	17.9	2428	12.4	600	344
sem, (n=72, 22 df	22.4	0.07	26.6	0.39	124	0.4	6.9	5.5
Nitrogen, kg ha^{-1}								
60	963	3.4	671	18.8	2242	11.9	592	340
90	1118	3.5	746	19.1	2270	12.6	597	345
120	1174	3.5	820	19.1	2330	13.1	600	349
sem, (n=72, 165 df)	15.4	0.06	16.9	0.22	57.6	0.13	3.6	3.1
Time of N application								
Seeding	1079	3.5	730	19	2235	12.5	598	346
Seeding & tillering	1092	3.5	761	18.9	2326	12.6	595	343
sem, (n=108, 165 df)	12.55	0.05	13.8	0.18	47	0.13	2.9	2.5
Mean	1085	3.5	745	19	2281	12.6	597	345

Table 2. Effects of rate and application time of nitrogen fertilizer on mineral composition of the regrowth of Westerwolds ryegrass, 3 year means

	Ca %	Mg %	Na %	P %	K %	S %	Cu ppm	Zn ppm	Mn ppm	Fe ppm	B ppm
Cultivar											
Aubade	0.58	0.22	0.071	0.33	2.23	0.25	4.87	20.7	116	72.5	3.34
Barspectra	0.59	0.23	0.059	0.30	2.27	0.23	5.02	17.8	129	64.4	3.46
Marshall	0.52	0.19	0.069	0.29	1.91	0.22	4.90	20.4	83	63.0	3.18
sem (n=72 , 22 df)	0.008	0.003	0.004	0.008	0.045	0.006	0.126	0.609	3.238	3.191	0.054
Nitrogen, kg ha $^{-1}$											
60	0.58	0.22	0.064	0.30	2.12	0.25	4.70	19.3	111	68.3	3.38
90	0.56	0.21	0.067	0.30	2.11	0.23	4.95	19.8	110	67.5	3.34
120	0.55	0.21	0.068	0.31	2.18	0.21	5.14	19.8	108	64.1	3.26
sem (n=72, 165 df)	0.005	0.002	0.002	0.003	0.025	0.003	0.070	0.187	1.594	1.456	0.034
Time of N application											
Seeding	0.57	0.21	0.065	0.30	2.12	0.23	4.97	19.6	111	67.5	3.35
Seeding & tillering	0.56	0.21	0.067	0.310	2.15	0.23	4.89	19.6	108	65.8	3.30
sem (n108, 165 df)	0.004	0.002	0.002	0.003	0.021	0.002	0.057	0.153	1.302	1.188	0.028
Mean	0.56	0.21	0.660	0.31	2.14	0.23	4.93	19.6	110	66.6	3.33